NASA Innovative Advanced Concepts

Spacecraft/Rover Hybrids for the Exploration of Small Solar System Bodies

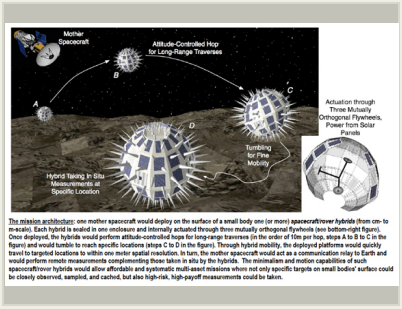
Completed Technology Project (2014 - 2016)

Project Introduction

The goal of this effort is to develop a mission architecture that allows the systematic and affordable in-situ exploration of small Solar System bodies, such as asteroids, comets, and Martian moons. Our architecture relies on the novel concept of spacecraft/rover hybrids, which are surface mobility platforms capable of achieving large surface coverage (by attitude-controlled hops, akin to spacecraft flight), fine mobility (by tumbling), and coarse instrument pointing (by changing orientation relative to the ground) in the low-gravity environments (micro-g to milli-g) of small bodies.

Anticipated Benefits

Collectively, our study aims to demonstrate that exploration via controlled mobility in low-gravity environments is technically possible, economically feasible, and would enable a focused, yet compelling set of science objectives aligned with NASA's interests in science and human exploration. Indeed, while controlled mobility in low-gravity environments was identified by the National Research Council in 2012 as one of NASA's high priorities for technology development, it has never been demonstrated in a high-fidelity low-gravity test bed. Hence, this proposal, if successful, would provide a sought-after and currently unavailable capability for small bodies exploration. This project would allow the systematic and affordable in situ exploration of small Solar System bodies. The exploration of these objects would allow for the evaluation of small bodies' potential for in situ resource utilization in view of future manned missions. The minimalism and motion capabilities of such spacecraft/rover hybrids would allow multi-asset missions where not only specific targets on small bodies' surface could be closely observed, sampled, and cached, but also high-risk, high-payoff measurements could be taken.



Project Image Spacecraft/Rover Hybrids for the Exploration of Small Solar System Bodies

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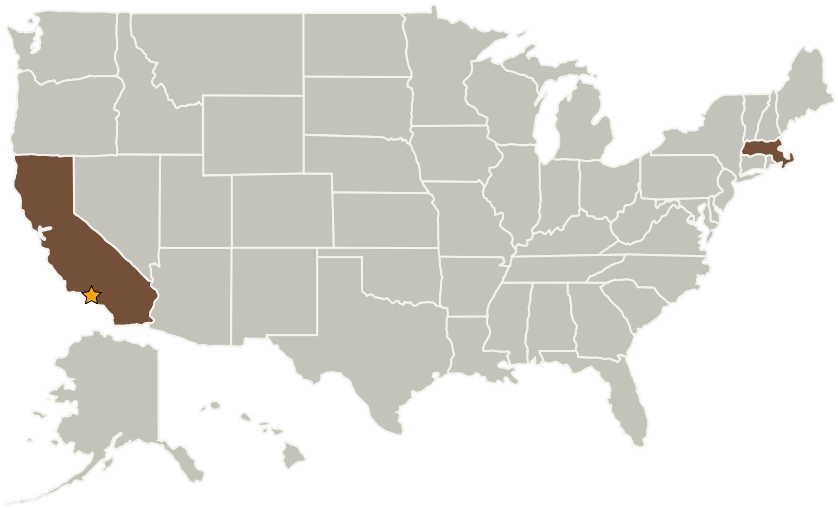
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California
Stanford University(Stanford)	Supporting Organization	Academia	Stanford, California

Primary U.S. Work Locations	
California	Massachusetts

Project Transitions

September 2014: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

Eric A Eberly

Principal Investigator:

Marco Pavone

Co-Investigators:

Julie C Castillo
Issa A Nesnas
Jeffrey A Hoffman
Andreas Frick

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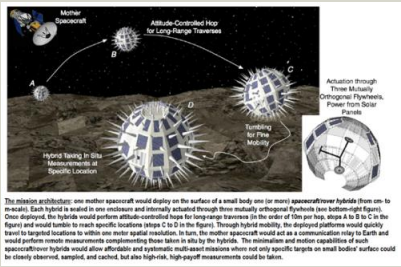
August 2016: Closed out

Closeout Summary: Due to NIAC he founded the Stanford Space Student Initiative - now has over 100 undergrads (and they have since broken the world record endurance high altitude balloons). Just finished Phase II but is ready to apply for GCD and ROSES Cubes Sat solicitation for Planetary Science of Deep Space Bodies and a small JPL grant Has been trying to interact with JAxA Japanese mission to Phobos and MMx (Mars Moon exploration)

Images



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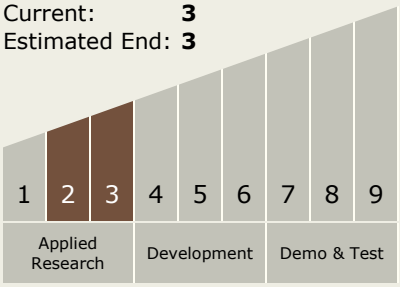
Project Image Spacecraft/Rover Hybrids for the Exploration of Small Solar System Bodies
(https://techport.nasa.gov/image/102211)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.2 Mobility
    - TX04.2.3 Small-Body and Microgravity Mobility

Target Destination

Others Inside the Solar System